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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Region III
841 Chestnut Building
Philadelphia, Pennsylvania 19107
November 8, 1991

FEDERAL EXPRESS

Keystone Environmental Resources, Inc.
3000 Tech Center Drive
Monroeville, PA 15146

Attn: Diane E. McCausland
Project Manager

Re: Submission of Draft Feasibility Study Report for
Atlantic Wood Industries Site, Portsmouth, VA

The purpose of this letter is to discuss preparation of the draft feasibility study (FS) report for the first operable unit (OU1) at the Atlantic Wood Industries Superfund (AWI) Site.

In a letter dated June 21, 1991, the Environmental Protection Agency (EPA) requested that Keystone Environmental Resources, Inc. (Keystone) prepare an FS report to address highly contaminated soil/sediment associated with the wood treating plant, historical disposal area, treated wood storage areas, intertidal drainage ditches and inlet, as well as dense non-aqueous phase liquids.

The Agency also recommended that Keystone consider establishing a long-term performance monitoring program as part of OU1, the objective of which is to: (1) determine pre-remedial chemical and biological baselines; (2) monitor effectiveness of the selected remedy; (3) determine improvement in environmental contaminant levels (e.g., rate of deposition of clean sediment) and (4) ascertain potential short-term biological recovery (e.g., decrease in toxicity and bioavailability). EPA further stated that such a performance monitoring program include synoptic sediment and biological monitoring. Finally, Keystone was informed that it may also be necessary to develop and implement measures to minimize further soil/sediment migration into the intertidal ditches and inlet.

In order to assist Keystone with the development of remedial alternatives, I have requested that researchers from EPA's Risk Reduction Engineering Laboratory (RREL) review the remedial investigation (RI) report for AWI. My intention was to solicit the opinions of technical experts regarding the application of various treatment technologies to contaminated soil/sediment at OU1.

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RREL has completed its review and I am enclosing a technical support package (attachment one) for your information. Attachment one should present Keystone with a clear indication of the technologies that EPA considers potentially applicable to OU1. Hopefully, this information will facilitate preparation of the draft FS report. Please contact me if you would like to discuss a particular technology with staff members from RREL.

Preparation of the FS was discussed during a July 16, 1991 meeting among representatives from EPA, AWI and Keystone, at which time both AWI and Keystone expressed concern regarding the potentially large volume of soil that would require remediation and the corresponding effects on cost estimates. EPA realizes that a more concise definition of the term "highly contaminated" would no doubt assist in preparation of the FS report. The Agency is also cognizant of the difficulties inherent to establishing cost estimates when the volume of contaminated soil requiring treatment is not yet firmly established. Keystone is referred to the discussion regarding costing procedures in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, October 1988, which states that a -30%/+50% cost estimate is acceptable for the purposes of the FS preparation.

I have spoken to both you and Jeff Smigel of AWI regarding the date when Keystone anticipates submitting the draft FS report to EPA. Based on our discussions, I was informed that, after site-specific cleanup levels have been established, Keystone would require approximately three (3) to four (4) months to prepare the draft FS report.

The Agency has been working closely with Keystone to derive soil/sediment cleanup levels for potential contaminants of concern (PCOCs) that are protective of the Columbia (surficial) Aquifer. EPA and the Virginia Department of Waste Management (VDWM) have received the draft *Interim Soil Cleanup Goals* report, which represents Keystone's attempt to generate soil/sediment cleanup levels by applying the Multimedia Exposure Assessment and Hydrologic Evaluation of Landfill Performance models. This document is currently being reviewed by EPA and VDWM and comments will be provided in the near future.

Through an Interagency Agreement with the National Oceanic and Atmospheric Administration (NOAA), EPA has developed target sediment cleanup levels for PCOCs that are protective of environmentally sensitive receptors. These cleanup levels are discussed in the final draft Ecological Risk Assessment report prepared by NOAA. This document has already been provided for the information of Keystone and AWI.

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According to Keystone, the human health risk assessment has been revised in accordance with EPA's toxicological comments. In this case, it will be possible to generate soil/sediment cleanup levels that address risk posed by dermal contact with, and accidental ingestion/inhalation of, PCOCs. Only after cleanup levels have been developed for every exposure pathway will it be possible for EPA to compare each and, ultimately, select cleanup levels for PCOCs at OU1.

In EPA's opinion, development of a schedule for implementing the remaining RI/FS tasks is essential. Unfortunately, EPA cannot establish timeframes for completion of subsequent project activities until an acceptable date for submission of the draft FS report has been confirmed. At the meeting of July 16, 1991, we also discussed the project schedule as it related to preparation of the Record of Decision (ROD) for OU1. As you are aware, the ROD for OU1 is currently targeted for March 31, 1992. This ROD commitment imposes time constraints upon EPA with respect to approval of the FS report and issuance of the proposed plan for remedial action.

In order to maintain any possibility of meeting the aforementioned ROD commitment, EPA must receive the draft FS report no later than December 6, 1991. If Keystone provided the draft FS by this date, there may exist sufficient time to ensure that: (1) the draft FS report is reviewed by EPA and VDWM; (2) regulatory agency comments are satisfactorily addressed by Keystone; (3) a final FS report is submitted to EPA and VDWM and (4) a proposed plan is prepared by EPA.

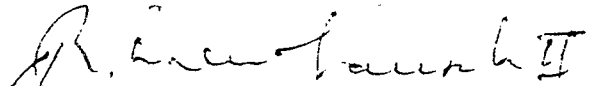
Typically, EPA initiates preparation of the proposed plan and ROD concurrent with review of the draft FS report, thereby ensuring that the proposed plan is issued to the public no later than two and one-half (2-1/2) months prior to the ROD date. In this case, the proposed plan would be issued on or about January 15, 1992. The Agency then schedules a public meeting to discuss the proposed plan and, as necessary, responds to all comments generated by the public. EPA uses the remaining time to complete the ROD. Given the timeframe for submittal of the FS currently proposed by Keystone, it will not be possible to achieve this goal.

EPA is committed to establishing a schedule for completion of remaining RI/FS activities at OU1. To this end, EPA believes that it would be advantageous to all parties if a meeting were scheduled to discuss the FS report. EPA is willing to schedule a meeting at your earliest convenience to discuss the aforementioned issues.

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In the meantime, please do not hesitate to contact me at (215) 597-1286 to discuss this matter. I look forward to hearing from you soon.

Sincerely,



Drew Lausch, RPM
VA/WV Remedial Section

Attachment

cc w/enclosures:

K. Hummel (EPA)
R. Smith (EPA)
D. Kargbo (EPA)
B. Davis (EPA)
K. Boyle (EPA HDQTRS)
S. Mihalko (VDWM)
J. Smigel (AWI)

cc w/o enclosures:

C. Rodrigues (EPA)
D. Wehner (NOAA)
W. Vogelbein (VIMS)

AR302696

**TECHNICAL ASSISTANCE SUPPORT
ATLANTIC WOOD INDUSTRIES SUPERFUND SITE
PORTSMOUTH, VA**

The Environmental Protection Agency (EPA), Region III requested technical assistance from EPA's Office of Research and Development, Risk Reduction Engineering Laboratory (RREL) regarding analysis/development of remedial alternatives at the Atlantic Wood Industries (AWI) Superfund Site. At the Region's request, this evaluation was limited to media associated with the first operable unit (OU1), which includes surface/subsurface soil, sediments (except those in the Elizabeth River), and dense non-aqueous phase liquids (DNAPL) in the surficial aquifer.

In particular, this review was performed with respect to the following remedial technologies: (1) thermal treatment; (2) biological treatment; (3) low temperature thermal desorption; (4) soil washing/flushing and (5) and solvent extraction. Review comments generated by RREL technical staff are discussed below:

THERMAL TREATMENT

For the purposes of soil characterization, the AWI Site has been divided into five areas (e.g., Area 4, Area 8, Area 9, Wood Treatment Area and Wood Storage Area). The following contaminants of concern, and corresponding ranges of concentrations, were detected in soil samples collected on-site: (1) arsenic at 8-495 ppm; (2) chromium at 4-527 ppm; (3) copper at 5-9780 ppm; (4) zinc at 40-20,400 ppm; (5) total volatile organic compounds (VOCs) at 1-3700 ppb; (6) total polynuclear aromatic hydrocarbons (PAHs) at 2-73,448 ppm; (7) pentachlorophenol (PCP) at 0.110-970 ppm and (8) dioxins/furans, as reported in 2,3,7,8-TCDD Toxicity Equivalent Concentrations (TECs), at non-detectable levels to 25 ppb.

Excavation at the portions of the site where contaminant levels exceed clean-up criteria and subsequent incineration of excavated soil is potentially feasible. Given the levels of contaminants detected in soil/sediment samples and the high destruction capabilities of incineration, this technology would be potentially applicable to the AWI Site. However, at any site where moderate levels of metals are present, it is suggested that a low-to moderate-temperature (e.g., 500 to 800 degree Fahrenheit) primary combustion chamber be considered. The low- to moderate-temperature combustor would minimize the fuming and "flying" of metal contaminants.

For this reason, the use of low temperature thermal desorption (LTTD) as a potential remediation technology should not be dismissed. RREL believes LTTD technology is sufficiently well developed to warrant its consideration at the AWI Site. Incineration might differ from LTTD in that the former would utilize a high-temperature (e.g., 2000+ degrees Fahrenheit) afterburner or secondary combustion chamber to assure complete (e.g., 99.99% - 99.9999%) destruction of organic contaminants.

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In the remedial investigation (RI) report, it was stated that "black beauty" sandblasting grit was present on site. Presumably, the term sandblasting implies that activities associated with paint removal have been conducted. If this were the case, it is conceivable that metals such as lead are present in soil/sediment. The presence of lead would reinforce the aforementioned comments regarding metals, especially since lead is a relatively volatile metal.

Finally, for Superfund Sites such as AWI, which contain mixed organics and metals, it is suggested that EPA or the PRP conduct thermal treatability studies on actual site samples. Ideally, such tests should be completed as early as possible (e.g., prior to issuance of the Record of Decision (ROD)). There are only a limited number of options with respect to facilities where tests can be performed and although costs are high, it is felt that such tests would be advisable, were incineration to be considered.

BIOLOGICAL TREATMENT

No detailed discussions concerning bioremediation options were included in the RI report. Rather, Keystone Environmental Resources Inc. (Keystone) indicates that technologies being considered "...include in-situ, on-site, and off-site technologies, as well as collection, treatment or disposal." The aforementioned technologies appear to include every approach that was not specifically eliminated in the RI report. The following comments and suggested pilot study formats for surface/subsurface soil bioremediation are offered.

An in-situ bioremediation pilot study for PAHs in a relatively water saturated site such as AWI is now currently underway for at least one other Superfund Site (Allied Signal Co., Ironton, OH). Work at Allied Signal involves introduction of hydrogen peroxide, via a central injection well, and recovery of injected water using four withdrawal wells, each positioned at the corners of the 15 x 15 foot test plot. The recovered water is then mixed with additional hydrogen peroxide and re-injected through the central well. Nutrients are sprinkled onto the soil surface and allowed to percolate through the soil. Where oxygen has been successfully delivered to the indigenous microbes, metabolism of PAHs has been increased. At some sites, problems have developed with clogging of the injection well screen as a result of increased microbial growth. Microbial catalysis of the hydrogen peroxide within one foot of the injection well has also been reported. This last problem causes early gaseous oxygen release, thereby significantly reducing the size of the effective oxygen transfer and enhanced treatment area.

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On-site land farming has been successfully used to remediate PAHs in surface soils, particularly benzo[a]pyrene, at a wood treatment site in Missouri (see attached discussion in *Tech Trends*, December 1990). This approach involved removing the soil to a polyethylene-lined storage area, preparing the excavated area for containment and drainage of contaminated water (creating a treatment cell) and filling the excavated area with a 9-inch layer of the original contaminated soil. The soil was tilled and irrigated (nutrients may be added as necessary) to facilitate indigenous biological activity. At another site in Florida, biodegradation (using land farming with indigenous organisms) of total PAHs to less than 10 mg/kg was accomplished at a site with original PAH concentrations in the thousands of mg/kg. This was accomplished in a time frame of 4 months/lift.

White rot fungi have been successfully used to biodegrade PCP-contaminated soils in experimental test plots of similar construction to the one described in the previous paragraph. White rot fungi could be utilized sequentially in the same test plot after PAHs, VOCs and some of the phenols have been removed by indigenous organism land farming. A second parallel test plot could be constructed to evaluate the effectiveness of white rot fungi in remediating mixed wastes, such as those found at the AWI Site, without the first-stage indigenous organism (unseeded with white rot) land farming step.

Water saturated subsoils present a unique challenge. They represent insolvable problems for some types of in-situ remediation and also complicate excavation. At the AWI Site, water saturated subsoils can be incorporated into the land farming protocol. This would involve transfer of the water saturated soils directly to the treatment cell. Excess water would be collected as drainage and stored at the treatment cell for use as irrigation water. This technology offers the advantage of allowing the land farm plot to serve as a biofilter to clean contaminated drainage from the saturated soil, as well as other contaminated water found on the site.

LOW TEMPERATURE THERMAL DESORPTION

The application of LTTD warrants further consideration. Prior to selection of LTTD, however, it is recommended that laboratory-scale screening tests be conducted. These tests should be performed after identifying the regulatory (federal, state and municipal) requirements that may be imposed on the system's operating conditions, gaseous emissions and solid/liquid discharges. This recommendation is based upon the following characteristics of the AWI Site:

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CONTAMINANTS

- Semi-volatiles are present in unspecified, but apparently considerable, quantity. Assessments should be limited to thermal desorption processes that are capable of achieving temperatures in excess of 650 degrees Fahrenheit in the primary chamber. Muffle furnace tests should be conducted to evaluate the optimum temperature range and the potential, for some compounds, to form dioxins during processing.

- With some exceptions, individual PAHs are generally present at concentration ranges of 1 ppm to 1000 ppm, with the arithmetic mean of total PAHs being 2,000 ppm. Consequently, the potential exists to successfully attain cleanup levels, while the possibility of reaching the lower explosive limit is small. The maximum concentrations reported (10% or 100,000 ppm) probably represent a small volume of highly contaminated material from discrete areas. This material should be blended with other soils that exhibit lower concentrations of contaminants.

- Total metal analyses are consistent with the types of operations conducted at this Site. It is not clear whether good judgement (e.g., decision based upon the type of operations at the site) was used to select the four metals (arsenic, chromium, copper and zinc) or whether they were the only metals detected during the RI. Although copper, chromium and zinc will probably remain with the soil, arsenic may volatilize, depending upon its compound. Tray tests should be conducted to determine the concentration of arsenic before and after heating. This information is necessary in order to determine the requirements of the air pollution control equipment and its ability to remove the arsenic compounds.

- Moisture content values were not reported; however, the text indicates that unspecified quantities of materials are sediments, in which case it would be necessary to dewater this material. Dewatering could be accomplished inexpensively if sufficient land area and time are available to permit solar drying. There exist numerous systems that are capable of dewatering sediments; however, they are more expensive than solar drying.

- With respect to soil physical characteristics, no U.S. Soil Conservation Service classifications were noted. Such information should be obtained since it is required to assess feedstock processing capabilities and materials handling requirements. Since the RI report indicates that much of the site has been "extensively filled" during the past 80+ years, almost anything could be found during excavation. Appropriate contingencies should be planned.

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SITE CHARACTERISTICS

- With respect to area available for potential operations, the AWI Site is of adequate size to support on-site treatment. Equipment mobilization and demobilization would therefore be routine.

- No summary of the total quantities of contaminated soil materials was provided. Such information should be obtained since it will have a significant bearing upon determining whether on-site or off-site treatment is appropriate.

- There is a fixed LTTD facility in Southern Virginia and several mobile units operate in the central Atlantic Coast area. Therefore, the availability of fixed or mobile processes will not be a problem.

ENVIRONMENTAL FACTORS

- With respect to average ambient temperature, southern Virginia has no long periods of cold weather that could adversely impact unit operations.

- Regulatory requirements are not addressed. This information would be necessary since it directly impacts the assessment and possible operation of such a treatment process.

SYSTEM CHARACTERISTICS

- Soil discharge temperature should be 300 degrees Fahrenheit or greater.

- Only those units that have an afterburner and a primary chamber, which can operate above 650 degrees Fahrenheit, should be considered.

SOIL WASHING/FLUSHING AND SOLVENT EXTRACTION

INTRODUCTION

Input is being provided regarding the technical feasibility of soil washing, soil flushing and solvent extraction, as well as the proposed treatment trains/technologies for the cleanup of contaminated soils/sediments at OU1, particularly in light of the presence of dioxins and furans.

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Solvent extraction employs a solvent-based extraction agent for organics removal, while soil washing uses various water-based additives for both organics and metals removal. In soil flushing, the soil washing processes are adapted to in-situ conditions, thereby requiring more accommodating site-specific soil characteristics than the soil washing technology.

Organics separation is effective with all three technologies. Whereas soil washing and soil flushing can remove metals contaminants using an acid or base washing additive, solvent extraction is limited to the solvent of choice for organics removal. Solvent extraction, however, appears to offer more efficient removal of dioxins and furans, which have low solubility and removal efficiency in soil washing/flushing, water-based systems.

The presence of dioxins and furans, as expressed in TECs, will not preclude the use of treatment technologies that might otherwise be suitable for soils and sediments more highly contaminated with the other potential contaminants of concern.

Based on the performance data, there is no clear choice among the three technologies discussed. If the levels of dioxins and furans do not require reduction, or specific areas with TECs above the action levels determined by EPA can be treated separately, soil washing/flushing can effectively treat soils containing organics and metals. If the dioxins and furans must be treated, solvent extraction can treat organics and dioxins/furans, but the metals contaminants must still be addressed by immobilization or soil washing.

Treatability testing would appear necessary to better define the applicability of these technologies to site-specific soil and contaminant(s) characteristics.

REVIEW OF RI REPORT

The RI report presents a summary characterization of the site in accordance with the *Guidance for Remedial Investigations and Feasibility Studies Under CERCLA* (EPA/540/G-89/004), October 1988. The data presented addresses the field investigation program, site physical characteristics, nature/extent of the contamination, identification of federal/state contaminant- and location-specific ARARs, and the public health and environmental risk assessment. This report was judged to be a creditable and acceptable basis for conducting this technology review.

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SUMMARY OF RI DATA

The following information represents a summary of RI data found on the tables and figures of Section 4.0 and summarily discussed in subsections 4.2 (soils), 4.4 (sediments) and 4.5 (non-soil materials).

Surface Soils

<u>contaminant</u>	<u>Site location</u>				
	WTA	WSY	4	8	9
	<u>concentration (ppm)</u>				
PAH	13,254	4,523	609	10,684	5,700
PCP	22	290	120	22	970
VOC	--	--	--	--	1.4
As	36	369	93	495	--
Cr	34	72	36	572	--
Cu	--	1,210	313	9,780	--
Zn	1,380	2,780	1,410	20,400	577

Subsurface Soils

<u>contaminant</u>	<u>Site location</u>				
	WTA	WSY	4	8	9
	<u>concentration (ppm)</u>				
PAH	73,448	2,224	15,810	50,134	243
PCP	290	170	42	1	43
VOC	--	--	--	--	--
As	445	89	--	43	--
Cr	31	17	--	21	--
Cu	715	2,180	--	1,620	--
Zn	2,670	1,110	1,940	2,990	209

Sediments (on-site ditches)

<u>contaminant</u>	<u>concentration</u> <u>(ppm)</u>	<u>contaminant</u>	<u>concentration</u> <u>(ppm)</u>
PAH	3,118	As	364
PCP	12	Cr	63
VOC	--	Cu	1,350
		Zn	1,890

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DNAPLs

<u>contaminant</u>	<u>concentration</u> <u>(ppm)</u>	<u>contaminant</u>	<u>concentration</u> <u>(ppm)</u>
PAH	260,000	As	--
PCP	960	Cr	--
VOC	--	Cu	--
		Zn	--

Dioxins/Furans TECs (ppb)Surface Soils

<u>Sample</u>	<u>TEC</u>	<u>Sample</u>	<u>TEC</u>
B1-S	0.025	7-6A	2.544
S9-S	0.218	7-1A	0.749
S13-A	0.770	5-7A	1.298
T1-4A	0.001	5-3A	9.172
T1-4PD	0.002	7-12A	6.063
T1-4F	0.030	7-10A	11.639
7-2A	7.102	4-5A IV	1.034
7-11	8.042	9E D	12.774
6-2A	2.048		

Subsurface Soils - Unsaturated

<u>Sample</u>	<u>TEC</u>	<u>Sample</u>	<u>TEC</u>
R11-A	0.598	T1-3A	0.724
S1-A	0.001	7-9B	0.496
S15-A	0.552	9C D	24.940
T1-A	0.034		(25.12)

Subsurface Soils - Saturated

<u>Sample</u>	<u>TEC</u>	<u>Sample</u>	<u>TEC</u>
S4-A	0.014	L-5	0.017
S7-B	0.000	S-4	0.018
S13-C	0.169	R-4	0.056
T1-3B	0.720	S-25	0.284
T1-4B	0.017	L-13	0.134
R1-4C	0.006	9A D	36.881
R1-4D	0.000	9H D	30.882
T1-4E	0.001	9H D	1.236
7A	7.592	9A D	0.193
2-5	0.895		

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- Notes:
1. WTA = Wood Treatment Area
WSY = Wood Storage Yard
4,8,9 = Area 4, Area 8 and Area 9, respectively
 2. -- indicates value less than 1 ppm.
 3. Subsection 4.5 TEC values were calculated from
TECs given in the RI report.

DIOXINS/FURANS CONSIDERATION

A concern exists whether the presence of dioxins and furans precludes the use of treatment technologies that might otherwise be suitable for soils/sediments. Based on this concern, the following discussion represents several technical considerations that should be addressed relative to the presence of dioxins/furans and the technical feasibility of applying the aforementioned extractive technologies.

- TECs for dioxin in surface soils and subsurface soils range from 0.001 ppb to approximately 12.8 ppb and 0.000 ppb to approximately 36.9 ppb, respectively. Those areas where TECs in soil (or residues resulting from treatment) exceed action levels determined by EPA should be considered separately, if possible, when planning a remedial action for the Site.
- The main consideration for determining the applicability of a technology, when very low levels of dioxin are found in the materials to be treated, is the manner in which the dioxin partitions between various residuals. If the dioxin concentrates in a particular residual, that residual may require further treatment to remove or destroy the dioxin. The chief residuals for extractive technologies are coarse solids, fine solids, and aqueous residues. Considerations for each of these streams are given below:
 - Dioxins and furans are solids under site conditions and exhibit very low solubility in water. They can easily be removed from aqueous media using a combination of sand filters followed by a carbon adsorption train. As a result, aqueous streams associated with soil flushing and soil washing should be easily treated.
 - The levels of dioxins and furans detected at the AWI Site should have negligible effect on the applicability of the soil flushing technology.

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- Since dioxins and furans are solids, their behavior in the solid residues is dependent on their particle size and their ability to adhere to solid surfaces. Contaminants tend to concentrate in the fine fraction of the soil. The best way to determine whether dioxin concentrates in the fine fraction is a bench scale treatability study. This can be executed by sieving a representative sample of soil and analyzing the size fractions for dioxins/furans.

In summary, both the levels of dioxins/furans and their disposition within the mechanisms of the extractive technologies do not preclude the use of these treatment processes, which are otherwise suitable for soils, sediments and ground water. However, based on the performance data presented herein, the use of these technologies as a primary treatment for dioxins/furans is not efficient. The ultimate disposition of the dioxins/furans may require post-treatment such as thermal destruction. Alternatively, areas at the site where TECs exceed the action level determined by EPA can be treated separately or excavated and removed off-site.

ASSESSMENT OF TECHNOLOGIES

Solvent Extraction

Solvent extraction is an excellent candidate technology for the removal of the PAH and halogenated phenol compounds. These compounds occur in the highest concentrations at the AWI Site. This technology has been demonstrated on PAHs for soils and sludges and should also be effective for sediments. The solvents may also remove some of the dioxins/furans, thereby resulting in an organic residue stream that is contaminated with low levels of dioxins/furans. Solvent extraction is generally not used in treating/removing inorganics and metals. The effectiveness of this technology is directly related to selection of a suitable organic solvent.

There are three main product streams generated by solvent extraction: (1) the treated soil, which may require dewatering, additional solvent removal and/or stabilization of metals (2) the concentrated contaminants, which may require additional analysis to determine their suitability for recycle, reuse or further treatment/disposal and (3) the separated water, which may require post-treatment prior to disposal.

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Soil Washing

Although soil washing may be effective in removing the PAH and halogenated phenol compounds from soils, it should be less effective than solvent extraction. The technology can be adapted for organics and metals and its effectiveness is directly related to the selection of a surfactant for organics removal and an acid or base for removal of metals. The low solubility of dioxin in soil washing water-based systems will require substantial amounts of washing medium; consequently, dioxin may not be as effectively removed as compared to solvent extraction processes.

Soil washing processes generate four principal waste streams: (1) contaminated solids, which require further chemical, thermal, biological, or stabilization/solidification treatment and disposal; (2) wastewater requiring further treatment prior to disposal; (3) wastewater treatment sludges/residuals, which must be appropriately treated prior to disposal and (4) air emissions, which must be collected and treated to meet applicable regulatory standards.

Soil Flushing

Soil flushing is an in-situ soil washing process that may also be effective in removing the PAH and halogenated phenol compounds from soils. However, it should be less effective than either solvent extraction or soil washing due to the uncertainties present when applying in-situ removal techniques. The effectiveness of this technology is directly related to the selection of water additives, which effect organics and metals removal, and the permeability of the soil.

The primary waste stream generated in the soil flushing process is contaminated flushing fluid that is recovered with the groundwater. Recovery of the flushing fluid, and treatment of the water for either reuse or disposal will produce sludges and residual solids requiring treatment/disposal. Air emissions must also be collected and treated to meet regulatory standards.

SUMMARY OF PERFORMANCE DATA

The following information is based on current treatability and demonstration data and presents a comparative summary of the relative removal efficiencies for each technology based on specific contaminants/contaminant groups. Given the data presented in the RI report, an approximate cleanup level for each contaminant of concern can be determined. For each of these technologies, however, specific data requirements must be satisfied and treatability studies should be performed to assess washing, extraction and flushing media, as well as process conditions and actual removal efficiencies.

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To date, out of 29 RODs written for wood preserver sites, solvent extraction and soil flushing were each selected twice and soil washing was selected in five instances. The following breakdown is provided:

<u>Contaminant</u>	<u>Technology</u>		
	<u>Solvent extraction</u>	<u>Soil washing</u>	<u>Soil flushing</u>
	<u>Removal efficiencies (wgt%)</u>		
PAH/VOC	95-98	72-99	72-90
PCP	91	96	90-95
Volatile metals	--	85-90	85
Non-volatile metals	--	90-99	90-95
Dioxins/furans	72	<70	<70
Approximate cost	\$100-\$500 per ton	\$50-\$205 per ton	\$50-\$120 per yard ³
Number of RODs w/technology selection	2	5	2

The cost figures presented represent total treatment costs for the separation/concentration options. It should be noted that these costs do not include pre- and post-treatment. Finally, the figures represent a comparative summary and caution is recommended in using these figures out of text.

CONCLUSIONS

Soil washing and its related in-situ technology, soil flushing, are both applicable to organics and metals but less effective in treating relatively water-insoluble dioxins and furans. Although solvent extraction is applicable to organics and more efficient than soil washing in treating dioxins and furans, this technology is generally ineffective in removing metals.

At levels detected during the RI, it does not appear as though dioxins and furans will impact the applicability of extractive technologies. If areas exhibiting elevated dioxin and furan concentrations must be specifically addressed, either those areas could be treated (e.g., thermal destruction) or excavated and disposed of separately. If this were not the case, and dioxin/furan concentration reduction must occur along with other contaminant reductions, solvent extraction may be employed. Further treatment to immobilize metals may still be required, however.

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In any case, treatability studies, based on site-specific soil/contaminant characteristics, would still be required to assess these technologies and determine post-treatment options for contaminated residuals, particularly possible accumulations of dioxins and furans.

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U.S. Environmental
Protection Agency
Office of Solid Waste and
Emergency Response
Technology Innovation Office

ORIGINAL

EPA/540/M-90/010 No. 3 December 1990

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Special Supplement
to **TECH TRENDS**

You will notice that this edition of *Tech Trends* contains an insert, "Innovations in Monitoring and Measurement Technologies". Although the focus of *Tech Trends* is usually on innovative cleanup technologies ready for field application, we also want to bring you news of other emerging tools that can assist you in emergency response, remediation, and corrective actions. Therefore, from time to time, we will include a special supplement like this one. In it, EPA's Environmental Monitoring Systems Laboratory in Las Vegas showcases three portable monitoring systems. The EPA Environmental Research Laboratory in Athens, Georgia, highlights a multispectral identification technique for non-target analytes that improves upon the current low resolution system. The Athens lab also presents information on alternatives to the Eh Probe for measuring mobility of heavy metals. Ada introduces BIOPLUME II.

The monitoring supplement may whet your appetite for the upcoming February symposium on monitoring. See "Conference Alert" on page 4 for more information.

On-Site Bioremediation at Scott Lumber Under a Performance Contract

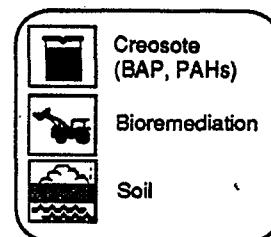
by Bruce Morrison, RPM, Region VII

Scott Lumber in Missouri is one of the largest Superfund sites in the United States where bioremediation has been employed. EPA's Region VII Emergency Planning and Response Branch (EP&R) laid the groundwork well for their choice of bioremediation. EP&R suspected that indigenous microbes were present at the site that could possibly convert the creosote contaminated soil into harmless compounds on-site. But concentration levels of the creosote compounds were quite high. For example, creosote contamination revealed concentrations of benzo-a-pyrene (BAP) as high as 260 parts per million (ppm), with total concentration levels of polynuclear aromatic hydrocarbons (PAHs) as high as 64,000 ppm. Any cleanup at the site had to protect the aquifer that is the primary source of drinking water for Alton, Missouri.

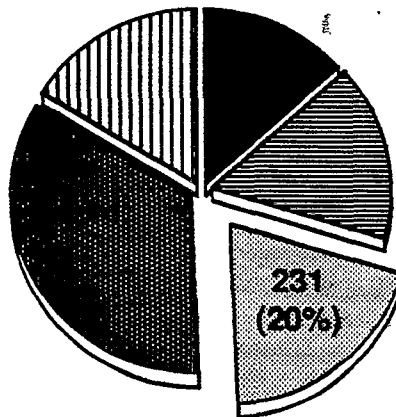
EPA established cleanup levels for the site at concentrations less than 14 ppm for BAP and 500 ppm for total PAHs. EP&R then conducted a literature search and tasked their Technical Assistance Team (TAT) to perform a treatability study, independent of cleanup contractors, to determine the feasibility of bioremediation. Both the literature and the treatability study indicated a strong potential for significant biodegradation of creosote compounds and possible cost savings when compared to conventional off-site disposal.

EPA's Emergency Response Contractor for Region VII subcontracted the services of Remediation Technologies, Inc. (RETEC) to clean up the site using bioremediation. The contract agreement was written as a fixed-price, performance specification contract; that

(see Bioremediation, page 3)



ATTIC: Thermal Treatment



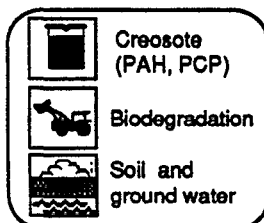
The Alternative Treatment Technology Information Center Database contains 231 citations on Thermal Treatment.

See "Out of the ATTIC" on page 3 for one user's experience.

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Bioremediation for Both Soil and Ground Water On-Site

With contaminants known to be biodegradable and indigenous



microbes on-site to do the biodegrading, the signs pointed toward bioremediation to clean up both soil and ground water at the Champion International Superfund Site in Libby, Montana. Over the years, the major contaminants at the site—creosote and polycyclic aromatic compounds and pentachlorophenol from former wood preserving operations—had contaminated a number of soil areas and migrated into the upper aquifer. A waste pit was also a source of ground-water contamination. Champion International, Inc. and Woodward Clyde, Inc. of Denver conducted bench-scale laboratory studies and pilot-scale *in situ* bioremediation studies that indicated that biodegradation in the soil was occurring and could be further enhanced by bioremediation treatment techniques. They determined that the ground water could be treated through bioremediation as well. The full scale bioremediation remedial design and remedial action are in various stages of implementation. Most of the cleanup work to date has focused on the contaminated soil.

The remediation contractor did not have to construct a special stockpile area for the soils. Soils from the contaminated areas scattered throughout the site are excavated and brought to the pre-existing waste pit. The pit serves as a staging area to pretreat the soils. In the pit, biodegradation is enhanced as soil is sprinkled with water and nutrients to support the growth and activity of bacteria. Further, a tiller aerates and homogenizes the soil, so that the soil concentrations are relatively even when placed on the final land treatment area.

However, prior to being placed in

(see *Soil and Ground Water*, page 4)



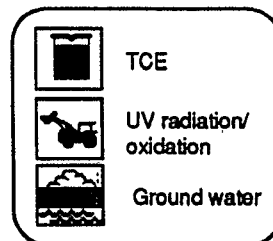
SITE Subjects

On-Site Chemical Destruction of Organics with Ultraviolet Radiation and Oxidation

ORIGINAL
(Red)

by Norma M. Lewis
Risk Reduction Engineering Laboratory

At a former drum recycling facility in San Jose, California, EPA demonstrated an innovative ultraviolet (UV) radiation/oxidation technology to treat ground water contaminated with volatile organic compounds (VOCs). Seven VOCs had been identified in the ground water, of which trichloroethylene (TCE), was the major contaminant. The ground water also contained dichloroethane (1,1-DCA) and 1,1,1-trichloroethane (1,1,1-TCA), which are relatively difficult to oxidize. The UV radiation/oxidation technology, developed by Ultrox International, chemically destroys organics in liquids (including those VOCs difficult to oxidize), with little or no harmful residuals from the process. During the testing at the San Jose site, no VOCs were detected in the exhaust from the treatment unit. The efficiency of destruction rendered the ground water in compliance with National Pollutant Discharge Elimination System (NPDES) standards at the 95% confidence level.



Essentially, the process uses a combination of UV radiation, ozone and hydrogen peroxide to oxidize organic compounds in water. The treatment system is comprised of four different treatment modules that are mounted on skids. The ozone generator module and hydrogen peroxide system feed into the UV radiation/oxidation reactor module. The liquid to be treated (ground water in the case of the San Jose site) is fed into the UV radiation/oxidation reactor. The reactor is divided into six chambers. Each chamber contains ultraviolet lamps and a diffuser that uniformly bubbles and distributes the ozone gas from the ozone generator through the liquid. The combination of the UV radiation, hydrogen peroxide and ozone chemically destroys the VOCs. Off-gassing ozone and any remaining VOCs in the reactor go to the catalytic ozone decomposer unit on top of the reactor where they are destroyed. The system allows you to enhance the oxidation of the organics according to the level of concentrations of the contaminants by adjusting parameters such as oxidant dose, UV radiation intensity and the pH level of the incoming ground water.

You have the option of pumping ground water directly from the aquifer into the reactor or of storing the liquid above ground for subsequent feeding into the reactor. At the San Jose site, the ground water was pumped into storage tanks because the flow from the wells was insufficient to support enough volume of water for flow through the reactor. The water was stored in inflatable heavy plastic bladder tanks. The construction of the inflatable tanks allows them to be filled to capacity, so that VOCs do not have space in the tank to off-gas into the air.

The Ultrox system achieved removal efficiencies as high as 90% for the total VOCs. The removal efficiency for TCE, the major contaminant at the site, was greater than 99 percent. The maximum removal efficiencies for 1,1-DCA and 1,1,1-TCA were about 65 and 85 percent respectively.

Use of the UV radiation/oxidation process at the San Jose site was part of the EPA Superfund Innovative Technology Evaluation (SITE) program. Overall, this treatment technology is intended to destroy dissolved organic contaminants, including chlorinated hydrocarbons and aromatic compounds, that are present in wastewater or ground water

(see *UV Radiation/Oxidation*, page 4)